Revision practice

International Baccalaureate · IB Diploma · Physics · HL

Original open focus revision; complete specification coverage remains unfinished.

1 Motion graphs and acceleration

- velocity
- acceleration

■ Question 1

What does area under a velocity-time graph represent?

- Displacement
- Acceleration
- Mass

Available marks: 2.

Worked answer

Displacement

- The gradient of a displacement-time graph is velocity. The area under a velocity-time graph gives displacement. A constant-acceleration formula is valid only when its assumption is justified.

■ Question 2

Velocity changes from 3 to 15 metres per second in 6 s. Find acceleration.

Available marks: 4.

Worked answer

2 $\mathrm{m/s^2}$

- Appropriate relation; consistent substitution; correct result; meaningful unit and interpretation.

Negative velocity indicates direction under the chosen sign convention; it does not necessarily mean slowing down.

2 Forces, momentum and safe stopping

- momentum
- resultant force

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■ Question 1

For fixed momentum change, which reduces average stopping force?

- Longer stopping time
- Shorter stopping time
- Ignoring external force

Available marks: 2.

Worked answer

Longer stopping time

- Impulse equals momentum change. Increasing stopping time for the same momentum change reduces average force. Identify external forces before applying momentum conservation.

■ Question 2

A 2 kg trolley travels at 3 metres per second. Find its momentum.

Available marks: 4.

Worked answer

6 kg · m/s

- Appropriate relation; consistent substitution; correct result; meaningful unit and interpretation.

Balanced forces do not require the object to be at rest. Mass and weight have different units and meanings.

3 Energy stores, work and efficiency

- power
- efficiency

■ Question 1

What happens to kinetic energy when speed doubles at fixed mass?

- It doubles
- It quadruples
- It stays constant

Available marks: 2.

Worked answer

It quadruples

- Define the system and useful output before calculating efficiency. Doubling speed quadruples kinetic energy at constant mass. Power describes transfer per time, not total energy.

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■ Question 2

A device receives 250 J and gives 150 J useful output. Find efficiency as a percentage.

Available marks: 4.

Worked answer

60 %

- Appropriate relation; consistent substitution; correct result; meaningful unit and interpretation.

Efficiency cannot exceed 100% for a properly defined energy balance. Energy dissipated by heating is still conserved.

4 Rigid bodies and rotational dynamics

- torque
- moment of inertia

■ Question 1

What increases torque for the same perpendicular force?

- A larger perpendicular lever arm
- A smaller lever arm
- Only changing the colour of the body

Available marks: 2.

Worked answer

A larger perpendicular lever arm

- For a rigid body about a fixed axis, net torque equals moment of inertia multiplied by angular acceleration. Rotational kinetic energy depends on angular speed squared. Angular momentum is conserved when net external torque is zero.

■ Question 2

A 12 N force acts perpendicularly 0.25 m from the pivot. Find torque.

Available marks: 4.

Worked answer

3 N m

- Appropriate relation; consistent substitution; correct result; meaningful unit and interpretation.

Torque has unit N m but is a turning effect, not an energy store. Moment of inertia changes if the same mass moves farther from the axis.

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5 Relativity and measuring events

- proper time
- inertial frame

■ Question 1

Where is proper length measured?

- In the object rest frame
- Only in any fast-moving frame
- In no frame at all

Available marks: 2.

Worked answer

In the object rest frame

- The Lorentz factor is 1 divided by the square root of 1 minus speed squared over light speed squared. Galilean velocity addition is an approximation for speeds much smaller than light speed.

■ Question 2

A proper interval is 8 microseconds and gamma is 1.25. Find the other-frame interval.

Available marks: 4.

Worked answer

10 μs

- Appropriate relation; consistent substitution; correct result; meaningful unit and interpretation.

Time dilation is not an instrument fault. Proper length is measured in the object rest frame; a contracted length is measured in a frame where it moves.

6 Thermal measurements and particle models

- specific heat capacity
- latent heat

■ Question 1

Why can temperature stay constant while a pure substance melts?

- No energy enters
- Energy changes particle arrangement
- The thermometer must be broken

Available marks: 2.

Worked answer

Energy changes particle arrangement

- Temperature relates to particle motion in a model; internal energy includes kinetic and potential contributions. During a change of state, energy can change particle arrangements rather than temperature.

■ Question 2

A 2 kg sample with c=500 J per kilogram per degree warms by 3 °C. Find energy gain.

Available marks: 4.

Worked answer

3000 J

- Appropriate relation; consistent substitution; correct result; meaningful unit and interpretation.

A flat section of a heating curve can show a phase change, not absence of energy transfer. Do not substitute temperature for a temperature difference in $E = mc\Delta T$.

7 Climate evidence, energy budgets and policy

- mitigation
- adaptation

■ Question 1

Which action is adaptation to flood risk?

- Raising vulnerable electrical equipment above expected flood level
- Measuring global CO_2 more often to track the cause
- Assuming the risk is zero until a flood happens

Available marks: 2.

Worked answer

Raising vulnerable electrical equipment above expected flood level

- Distinguish mitigation, which addresses drivers, from adaptation, which reduces harm from impacts. A policy assessment needs evidence about effectiveness, cost, equity and uncertainty; one criterion is not the entire decision.

■ Question 2

Incoming energy is 240 units and reflected energy 72. Find reflected percentage.

Available marks: 4.

Worked answer

30 %

- Appropriate relation; consistent substitution; correct result; meaningful unit and interpretation.

The greenhouse effect is not the same process as ozone depletion. A carbon footprint estimate depends on its system boundary.

8 Gas models and absolute temperature

- absolute temperature
- ideal gas

■ Question 1

Which scale belongs in a gas-law temperature ratio?

- Celsius
- Kelvin
- Either scale without conversion

Available marks: 2.

Worked answer

Kelvin

- At fixed amount and volume, pressure is proportional to kelvin temperature. At fixed temperature and amount, pressure is inversely proportional to volume. State which quantities are fixed before choosing a relationship.

■ Question 2

At fixed volume, pressure is 120 kPa at 300 K. Find pressure at 350 K.

Available marks: 4.

Worked answer

140 kPa

- Appropriate relation; consistent substitution; correct result; meaningful unit and interpretation.

An ideal gas is a model with conditions of validity. Celsius zero is not zero molecular motion, and internal energy is not determined by pressure alone.

9 Thermodynamic systems and energy accounts

- adiabatic
- internal energy

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■ Question 1

In this convention, what happens during adiabatic compression?

- Internal energy increases
- Heat must enter
- Work done by the gas is positive

Available marks: 2.

Worked answer

Internal energy increases

- State a sign convention before using the first law. Here change in internal energy equals heat into the system minus work done by the system. Expansion work can reduce internal energy when no heat enters.

■ Question 2

A gas gains 500 J of heat and does 200 J work. Find internal-energy change.

Available marks: 4.

Worked answer

300 J

- Appropriate relation; consistent substitution; correct result; meaningful unit and interpretation.

Adiabatic does not mean constant temperature. Use the stated sign convention; some courses write work done on the gas with the opposite sign.

10 Current, potential difference and resistance

- current
- potential difference

■ Question 1

How is a voltmeter connected to measure voltage across a resistor?

- In parallel with the resistor
- In series only
- Across the ammeter only

Available marks: 2.

Worked answer

In parallel with the resistor

- Current is the same through components in series. Potential differences add around the series path. In parallel, branches share the same potential difference, while branch currents sum at a junction.

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■ Question 2

A component has 12 V across it and carries 0.40 A. Find resistance.

Available marks: 4.

Worked answer

30 Ω

- Appropriate relation; consistent substitution; correct result; meaningful unit and interpretation.

Current is not used up by a lamp. A filament heats up, so its resistance need not remain constant as voltage changes.

11 Oscillation, resonance and phase

- resonance
- damping

■ Question 1

For ideal SHM, where is speed greatest?

- At equilibrium
- At maximum displacement
- At every point equally

Available marks: 2.

Worked answer

At equilibrium

- Velocity is greatest near equilibrium for ideal SHM, while acceleration magnitude is greatest at extreme displacement. Resonance can occur near the natural frequency under periodic driving, with amplitude limited by damping.

■ Question 2

30 cycles take 45 s. Find period.

Available marks: 4.

Worked answer

1.5 s

- Appropriate relation; consistent substitution; correct result; meaningful unit and interpretation.

Not every repeated motion is SHM. A force proportional to displacement but directed away from equilibrium does not produce SHM.

12 Waves, measurement and refraction

- wavelength
- frequency

■ Question 1

When a wave enters a slower medium, what stays constant?

- Frequency
- Wavelength
- Speed

Available marks: 2.

Worked answer

Frequency

- At a boundary, frequency stays fixed by the source. A change of speed changes wavelength. Refraction follows from speed differences; angles are measured from the normal.

■ Question 2

Frequency is 8 Hz and wavelength is 0.25 m. Find wave speed.

Available marks: 4.

Worked answer

2 m/s

- Appropriate relation; consistent substitution; correct result; meaningful unit and interpretation.

The wave frequency does not change simply because the medium changes. A longitudinal wave has oscillations parallel to propagation.

13 Spectral shifts: a low-speed astronomical estimate

- redshift
- rest wavelength

■ Question 1

What does an identified line shifting to a longer wavelength suggest in the stated model?

- Recession along the line of sight
- Light speed increased
- The source frequency must be zero

Available marks: 2.

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Worked answer

Recession along the line of sight

- Compare a identified line with its laboratory rest wavelength. Use z = (observed−rest)/rest, then v approximately cz in the stated low-speed model. Do not apply this approximation without checking the regime or treating a cosmological redshift as a simple exact velocity.

■ Question 2

A 600 nm rest line is observed at 601.2 nm. Find z=(observed−rest)/rest.

Available marks: 4.

Worked answer

0.002

- Appropriate relation; consistent substitution; correct result; meaningful unit and interpretation.

The approximate shift relation does not show that light travels faster from an approaching source. A single unidentified line cannot safely establish a redshift.

14 Doppler effect: separate source motion from wave speed

- Doppler shift
- wavefront

■ Question 1

Why is pitch higher in front of an approaching sound source?

- Wavefront spacing is smaller
- Sound speed must become infinite
- The listener creates extra source oscillations

Available marks: 2.

Worked answer

Wavefront spacing is smaller

- For a source approaching a stationary observer along the line of sight, f observed = f source × v/(v−v source). Recession uses v+v source in the denominator. These are sound-wave models; light requires its appropriate relation.

■ Question 2

A 600 Hz source approaches a stationary observer at 20 m/s. Use v = 340 m/s. Find observed frequency. Give the frequency to three significant figures.

Available marks: 4.

Worked answer

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638 Hz

- Appropriate relation; consistent substitution; correct result; meaningful unit and interpretation.

A stationary source and moving observer require the observer-motion relation. Do not use the same denominator formula for every arrangement or import a sound formula into relativity.

15 Gravitational fields and orbital motion

- gravitational field
- centripetal force

■ Question 1

What direction is the net force in uniform circular motion?

- Toward the centre
- Along the velocity
- Always outward

Available marks: 2.

Worked answer

Toward the centre

- For a point mass or outside a spherical mass, field strength follows an inverse-square distance dependence. Use distance from the centre, not height above the surface alone.

■ Question 2

Field strength is 18 units at r. Find it at 3r for an inverse-square field.

Available marks: 4.

Worked answer

2

- Appropriate relation; consistent substitution; correct result; meaningful unit and interpretation.

Weightlessness in an orbiting spacecraft means apparent weight is small in free fall, not that there is no gravitational field.

16 Electric fields: force and a positive test charge

- electric field strength
- test charge

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■ Question 1

What happens to force direction if the test charge changes sign?

- It reverses in the same field
- It always stays along the field
- The field ceases to exist

Available marks: 2.

Worked answer

It reverses in the same field

- In a uniform field between ideal parallel plates, E = V/d away from edge effects. The force is F = qE, so its direction reverses for a negative charge. Coulomb force between ideal point charges decreases with separation squared.

■ Question 2

Use E = V/d. Find E for 100 V across 0.025 m.

Available marks: 4.

Worked answer

4000 V/m

- Appropriate relation; consistent substitution; correct result; meaningful unit and interpretation.

Field strength is a vector. Potential difference is energy per charge and is not the same quantity. A field-line drawing is a model, not a set of physical threads.

17 Magnetic forces: turn velocity without increasing speed

- magnetic force
- momentum

■ Question 1

What changes under a magnetic force alone in perpendicular circular motion?

- Velocity direction
- Kinetic energy continuously increases
- Charge magnitude

Available marks: 2.

Worked answer

Velocity direction

- Equate magnetic force with mv^2/r to obtain $r = mv/(|q|B)$ for perpendicular motion. A stronger field makes a smaller radius at fixed momentum. Parallel entry gives zero magnetic force in this model.

■ Question 2

Use r = mv/(|q|B). For m=2×10^{-27} kg, v=2×10^{6} m/s, |q|=1×10^{-19} C and B=0.20 T, find r.

Available marks: 4.

Worked answer

0.2 m

- Appropriate relation; consistent substitution; correct result; meaningful unit and interpretation.

A magnetic force can change momentum direction without doing work. Adding an electric field can change the energy, so conclusions about a magnetic field alone do not cover every combined-field apparatus.

18 Fields, motors and induction

- induction
- transformer

■ Question 1

Which gives a continuing emf in a coil?

- A constant unchanging flux
- A changing flux linkage
- A nearby stationary magnet in every situation

Available marks: 2.

Worked answer

A changing flux linkage

- Changing field strength, coil area, orientation or relative motion can change flux linkage. Lenz law describes an induced effect opposing the change producing it, consistent with energy conservation.

■ Question 2

An ideal transformer has Np=400, Ns=100 and Vp=20 V. Find Vs.

Available marks: 4.

Worked answer

5 V

- Appropriate relation; consistent substitution; correct result; meaningful unit and interpretation.

A transformer needs changing magnetic flux; a steady DC input does not provide continuous transformer action. Magnetic field direction is not automatically the direction

of force.

19 Atomic models and line spectra

- emission spectrum
- energy level

■ Question 1

What produces a higher-frequency emitted photon?

- A larger downward energy difference
- Any transition upward without absorption
- A smaller Planck constant for the same atom

Available marks: 2.

Worked answer

A larger downward energy difference

- An emitted photon corresponds to a transition to a lower energy level. Absorption requires a compatible energy difference. Rutherford scattering supported a small dense nucleus, but that experiment alone did not establish the complete quantum model.

■ Question 2

Levels are -7.0 and -2.0 eV. Find the energy emitted in the downward transition.

Available marks: 4.

Worked answer

5 eV

- Appropriate relation; consistent substitution; correct result; meaningful unit and interpretation.

Negative bound-state energies are relative to a chosen zero; they do not mean a negative photon energy is emitted. A larger downward energy difference gives higher frequency.

20 Photons and the photoelectric effect

- photon
- work function

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■ Question 1

At fixed above-threshold frequency, increasing intensity mainly increases what?

- The energy of each photon
- The number of electrons emitted per second
- The work function of the metal

Available marks: 2.

Worked answer

The number of electrons emitted per second

- Use photon energy = Planck constant × frequency. Maximum kinetic energy = photon energy - work function. Increasing intensity at fixed frequency increases photon arrival rate, not individual photon energy.

■ Question 2

Photon energy is 4.8 eV and work function 2.1 eV. Find maximum kinetic energy.

Available marks: 4.

Worked answer

2.7 eV

- Appropriate relation; consistent substitution; correct result; meaningful unit and interpretation.

Electrons do not accumulate many sub-threshold photons in the elementary single-photon model. Do not confuse photon number with photon energy.

21 Nuclear changes and radiation evidence

- half-life
- background radiation

■ Question 1

Which count should be used for source activity?

- Raw source-plus-background only
- Measured count minus background over equal times
- The largest repeated count only

Available marks: 2.

Worked answer

Measured count minus background over equal times

- Subtract background counts measured over the same time interval. Distinguish irradiation from contamination. Shielding, distance and reduced exposure time can reduce risk under a school-controlled procedure.

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■ Question 2

An initial source count is 160 per minute. Find it after three half-lives.

Available marks: 4.

Worked answer

20 counts/min

- Appropriate relation; consistent substitution; correct result; meaningful unit and interpretation.

An irradiated object is not automatically radioactive. A half-life does not predict the exact decay time of one nucleus.

22 Fission: conserve charge and nucleons, account for energy

- fission
- chain reaction

■ Question 1

What permits a continuing fission chain reaction?

- Released neutrons initiate further fissions
- Every emitted neutron must escape
- Charge conservation is suspended

Available marks: 2.

Worked answer

Released neutrons initiate further fissions

- Separate conservation of nucleon number from conservation of total energy. Released neutrons may initiate further fissions, escape or be absorbed. A controlled reactor and an uncontrolled chain reaction have different neutron-management conditions.

■ Question 2

A U-235 nucleus plus one neutron produces fragments with mass numbers 141 and 92. How many neutrons balance the equation?

Available marks: 4.

Worked answer

3 neutrons

- Appropriate relation; consistent substitution; correct result; meaningful unit and interpretation.

Mass number is not a precise mass in kilograms. Balanced integer labels alone do not calculate the released energy. Radioactive decay and neutron-induced fission are not

interchangeable descriptions.

23 Stars, radiation and scale

- luminosity
- flux

■ Question 1

At fixed luminosity, what happens to flux when distance doubles?

- It halves
- It becomes one quarter
- It doubles

Available marks: 2.

Worked answer

It becomes one quarter

- For isotropic emission without absorption, flux follows an inverse-square relationship with distance. Observed brightness alone therefore cannot establish luminosity.

■ Question 2

A source gives flux 18 units. Find flux at three times the distance.

Available marks: 4.

Worked answer

2

- Appropriate relation; consistent substitution; correct result; meaningful unit and interpretation.

The Sun is not expected to become a supernova. Redshift can support cosmological expansion; it does not mean every nearby object must move away from every observer.

24 Uncertainty, gradients and model testing

- uncertainty
- systematic error

■ Question 1

Which is most likely a systematic error?

- A balance reads 0.20 g when empty
- Repeated values fluctuate either side of the mean
- Random differences in reaction time

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Available marks: 2.

Worked answer

A balance reads 0.20 g when empty

- For a product or quotient, adding fractional uncertainties is a common maximum-uncertainty approximation. For a difference, add absolute uncertainties. A nonzero intercept can reveal an offset or an incomplete model.

■ Question 2

A 40 cm reading has an absolute uncertainty of 1 cm. Find percentage uncertainty.

Available marks: 4.

Worked answer

2.5 %

- Appropriate relation; consistent substitution; correct result; meaningful unit and interpretation.

Repeating readings reduces random uncertainty in a mean but does not automatically remove a zero error. Do not quote more decimal places than your measurement can support.